MOBILITY PATTERNS IN POWER WHEELCHAIR USERS AND THE IMPLICATIONS FOR MEASURING MOBILITY

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INTRODUCTION

Little literature is available concerning the mobility patterns of wheelchair users. Some generalized values of power wheelchair (PWC) use are available in terms of average distances and speeds over all subjects and days (Cooper 2002). However, the data lack the context of environment and do not identify how the movement is dispersed over time. Greater insight into PWC use and mobility patterns at home and outside will allow us to better understand the consequences of unmet mobility needs in both environments. While a study of this sort should be performed on manual wheelchair users and ambulatory persons with mobility impairments (such as those who use crutches or walkers), the burden of instrumentation makes it difficult and thus a study was first completed on PWC users.

This study aims to describe mobility patterns of PWC users in the home and outside. It also aims to describe the implications of these mobility patterns for the development of future studies and interventions for other populations with mobility impairments.

METHODS

A convenience sample of 25 adults (16 male, 9 female, mean age 46 yrs) with some affiliation to the location spinal cord injury rehabilitation center who used PWCs as their primary mobility devices were recruited for this study with IRB approval. All subjects signed informed consent forms.

Subjects' wheelchairs were instrumented with monitoring sensors for 1-2 weeks. Wheel counts were recorded on a single wheel using a reed switch and 2-4 evenly spaced Neodymium magnets. The sum of wheel counts was recorded in two second epochs on a custom data logger (Levo and Consonics, Switzerland). A Garmin GPS receiver and custom GPS logger (GeoStats, Atlanta, GA) recorded the latitude and longitude of the wheelchair every 5 seconds. GPS data was processed and used in a prompted recall interview during which we determined the subject's environment (i.e. location and indoors or outdoors) and what activities they were performing.

Post-processing of the data was done using GeoStats' software and custom Matlab code. Wheel counts were converted to distances and then bouts were computed. Bouts were defined as intentional, continuous bursts of movement beginning when a subject traveled 2 feet within four seconds and continuing until the subject traveled less than 2.5 feet over 14 seconds.

RESULTS AND DISCUSSION

Overall, most subjects wheeled very small distances (Table 1). However, the distribution of that distance was quite varied. The percent of total distance wheeled inside the home ranged from 3% to 93% (median 57%). However, the distribution of bouts was much more consistent. 16 of 21 subjects wheeled more than 60% of their bouts at home.

Table 1: Median (range) of daily wheelchair use was widely distributed over subjects.

	Distance (mi)	# Bouts
Overall	0.7 (0.1-6.6)	110 (36-281)
At Home	0.3 (0.0-0.9)	72 (5-204)
Outside	0.0 (0.0-4.4)	1 (0-31)

Wheelchair use outside was highly skewed. The median distance is representative of 15 of 21 subjects who wheeled less than 20% of their total distance outside. The remaining 6 predominantly wheeled outside.

In this study, the nature of mobility differed with environment (Table 2). Outside, subjects were more likely to travel a greater distance over a continuous bout of movement and reach a higher speed. At home, however, bouts were short and slow.

Table 2: Average bout parameters are dependent on environment.

	Distance (ft)	Duration (min)	Speed (mph)
Overall	53	0.5	1.2
At Home	23	0.4	0.6
Outside	329	1.6	2.4

The subject data presented in Figure 1 illustrates this behavior. The subject wheeled an average of 0.3 miles per day, 92% of which occurred in the home. The movement was spread out over 140 bouts and nearly 12 hours per day. The average bout went only 13 feet and only 1% of the bouts exceeded 50 feet.

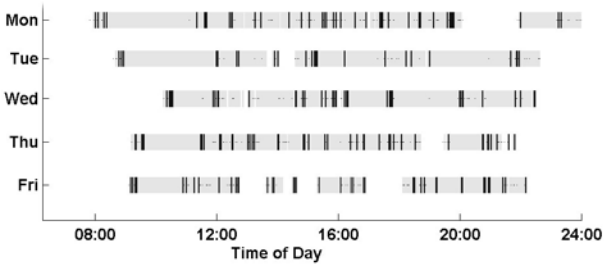

Figure 1: Wheelchair use for one subject. Gray bars indicate when subject was in wheelchair and vertical lines show mobility.

SUMMARY/CONCLUSIONS

PWC users do not have to exert additional energy to continue movement or move quickly, and yet their mobility bouts remain short and slow. Because this is likely to be true for other populations with mobility impairments, mobility should always be studied in terms of bouts as well as overall distances. When studying the biomechanics of manual wheelchair propulsion, one group found that the amount of torque needed to initiate movement is twice that needed during steady-state propulsion (Koontz, 2005). Given the prevalence of shoulder pain in people who use manual wheelchairs, this suggests that rehabilitation interventions may need to target the initial stroke of propulsion.

For persons with mobility disabilities, it appears that the predominant mobility requirement within the home is the ability to initiate movement, rather than to engage in high-speed, steady-state movement. Therefore, when studying persons with mobility impairments or developing rehabilitation interventions, one should focus on the initiation and termination of movements. Lastly, the design of mobility aids for use in the home should be optimized for safe initiation and termination of movement.

REFERENCES

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ACKNOWLEDGEMENTS

Support was provided by NIDRR via the RERC on Wheeled Mobility and the NSF Graduate Research Fellowship Program.